# NASA Facts

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# PHYSX

## Pegasus HYperSonic EXperiment

Imagine a new breed of aircraft that could travel 3750 mph (at sea level) and make a trip from Los Angeles to New York City in a little more than 45 min.

NASA is working to make these aircraft of the future possible through research into the world of hypersonics, or flight at speeds faster than five times the speed of sound.

One of these exciting areas of research is the Pegasus Hypersonic Experiment project, managed by the NASA Dryden Flight Research Center, Edwards, CA.

The experiment consists of a smooth, information-gathering “glove” installed on the first-stage wing of the Pegasus Space Launch Vehicle, which reaches speeds of Mach 8 and altitudes of 200,000 ft. The glove is bonded to the right wing and wraps from the underside of wing, over the leading edge and onto the upperside, although it does not cover the wing completely.

The experiment will gather information about how the air flows over the Pegasus wing. Scientists are particularly interested in the transition of air from smooth (laminar) to turbulent flow. The goal of the experiment is to discover when the airflow over the wing becomes turbulent and why.

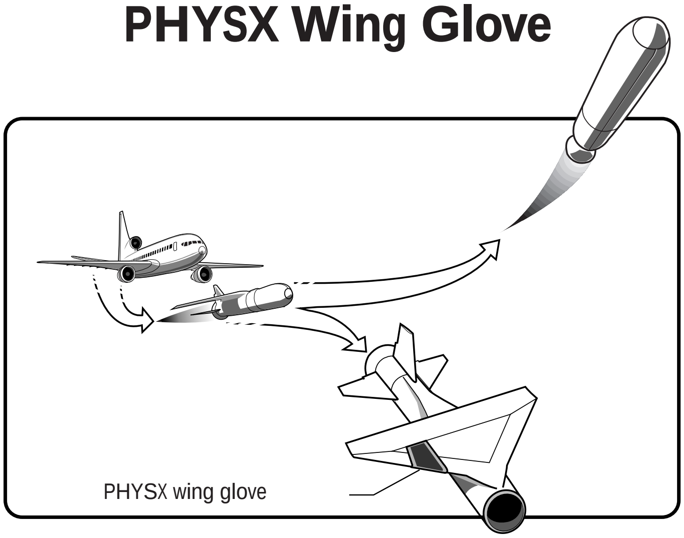
Airflow has a great impact on how hot vehicles get. Turbulent air generates a lot of heat because of increased friction, which can cause burns on aircraft.

The hypersonic X-15 experienced such problems due to turbulence-induced friction. In addition, turbulent air creates more “drag,” slowing down aircraft or making them less efficient.


*The Orbital Sciences Corp.'s Pegasus booster rocket is mated to Dryden's B-52. Orbital's L-1011 now serves as the Pegasus mothership.*

Data from the Pegasus glove experiment also will include temperature, heat transfer and pressure measurements, as well as reconstruction of the Pegasus flight path. This experiment will provide critical information that can’t be obtained anywhere else, as wind tunnels here on the ground can't adequately simulate both the hypersonic speeds and atmospheric conditions the Pegasus booster encounters.

## L-1011, Pegasus, and the PHYSX Wing Glove




At about 38,000 feet, the Pegasus booster drops from the L-1011 aircraft, and its engine ignites. The PHYSX glove gathers data for about a minute and a half before the first stage burns out and falls away. The Pegasus and its payload continue their ascent.

A secondary goal for the program is to provide engineers with valuable experience in instrumenting and testing hypersonic vehicles.

The Pegasus Hypersonic Experiment is one way that NASA is meeting its goal of achieving revolutionary technology leaps to make aeronautics and space programs more affordable. This goal aims to revolutionize the way in which aircraft are designed, built and operated.

## Flight Scenario

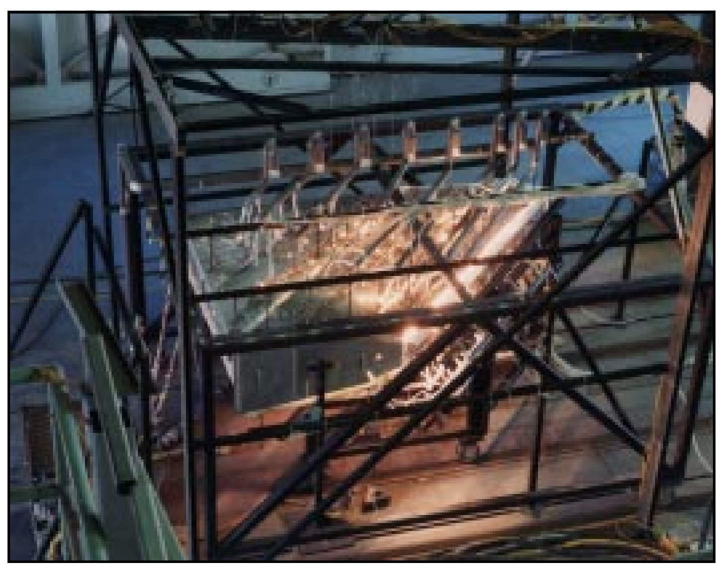
The hypersonic glove experiment currently is scheduled to fly in October 1998. The Pegasus booster's primary goal for the mission, which will originate from the Cape Canaveral Air Station, Cape Canaveral, FL, is to launch a commercial satellite payload. Pegasus will carry the glove aloft as a secondary mission that will not interfere with the launch vehicle's primary goal.

Once the first stage Pegasus booster rocket launches from its L-1011 mothership, the highly instrumented glove will be able to gather information about flight at high speeds and altitudes. Sensors in the glove will only be able to gather information for about a minute and a half before the first-stage of the rocket burns out and is jettisoned.

All information the glove obtains will be transmitted to the ground through a radio signal as the glove will not be recovered. To make transmitting the data possible, engineers at the NASA Langley Research Center, Hampton, VA, developed a special data acquisition, compression and processing system. In January 1995, Dryden's F-15 aircraft tested the system during a series of flights over Edwards Air Force Base, CA.

## Glove

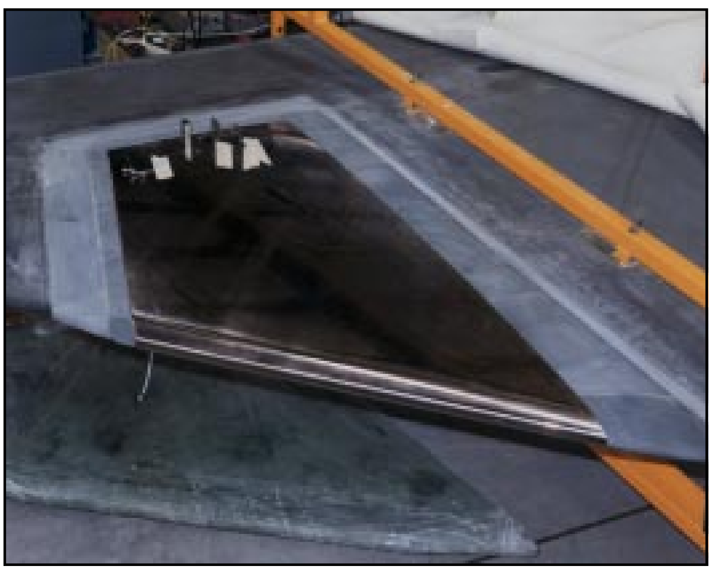
Two Pegasus Hypersonic Experiment gloves were manufactured for the program — one that will fly aboard the Pegasus booster rocket and one earmarked for thermal ground tests. Both gloves are made of nickel-plated steel.



*The nickel-plated steel glove, shown here undergoing heat tests in 1996, is bonded to the right wing and wraps from the underside of wing, over the leading edge and onto the upperside, although it does not cover the wing completely.*

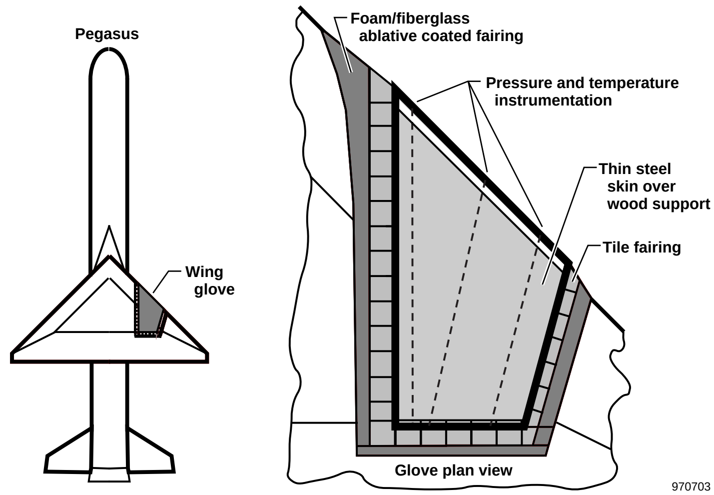
The ground-test glove was mounted on a plywood and fiberglass structure for a series of tests that concluded May 30, 1996. The glove was painted a flat black to maximize heat absorption. During the tests, engineers precooled the glove and heated it in NASA Dryden's Flight Loads Laboratory, simulating the heat the glove will experience during its first-stage flight profile. The tests revealed that the glove is hardy enough to survive the intense heat it will experience while traveling at eight times the speed of sound.

The flight-test glove is mounted on balsa wood and surrounded by a drag-reducing thermal protection system structure made of Space Shuttle tile material that blends the glove into the wing. NASA Ames Research Center, Moffett Field, CA, supplied the thermal protection system, which dissipates heat. The glove was mounted to the Pegasus wing at Dryden. The Pegasus booster rocket will be secured to its L-1011 launch vehicle at the Orbital Sciences Corp.'s Vehicle Assembly Building at Vandenberg Air Force Base, CA.



The experimental glove is made of nickel-plated steel and carries pressure and temperature instrumentation, among other instruments.

The glove carries a variety of traditional and high-frequency sensors capable of functioning during the flight conditions the Pegasus rocket will experience. The sensors will give engineers a variety of information like acceleration, air flow, pressure, temperature and strain. Many of these sensors were evaluated in July 1994 aboard an earlier Pegasus mission. The mission verified that the sensors do not interfere with the airflow over the Pegasus wing and that the vibrations the sensors will experience during flight will not interfere with obtaining accurate data.




## Roles and Responsibilities

Dryden is providing overall management of the glove experiment, glove design and buildup. Dryden also is responsible for conducting the flight tests. Langley is responsible for the design of the aerodynamic glove as well as development of sensor and instrumentation systems for the glove. Other participating NASA centers include Ames; Goddard Space Flight Center, Greenbelt, MD; and Kennedy Space Center, FL. Orbital Sciences Corporation, Dulles, VA, is the manufacturer of the Pegasus vehicle, while Vandenberg Air Force Base serves as a pre-launch assembly facility.

## Pegasus Background

First flown in 1990, Orbital Sciences Corp.'s Pegasus rocket supports a wide range of missions, including space technology validation, earth science and space physics experiments, hypersonic flight research, earth imaging, communications and planetary exploration. The three-stage Pegasus launch vehicle is carried aloft by the company-owned L-1011 "Stargazer" aircraft to a point approximately 40,000 ft over open ocean areas, where it is released and then free-falls in a horizontal position for five seconds before igniting its first stage rocket motor. With the aerodynamic lift generated by its delta wing, the small rocket achieves orbit hundreds of miles above the Earth in approximately ten minutes. Pegasus is capable of carrying payloads up to 1,100 lb.